Main Governor and Speed Changer

Figure 1 shows the governor, which is of the vertical shaft, fly ball type, in which the revolving weights "29" move in response to changes in centrifugal force resulting from changes in speed. Movements of these weights are transmitted to a relay "31" which controls the flow of high pressure oil to and from the operating cylinder. Movements of the operating piston "35" are transmitted by a lever, and suitable linkage to the governing valves. The oil required to operate the valve operating piston "35" is supplied by the main oil pump and is led to the high pressure oil inlet chamber of the relay through an external pipe.

The governor hub "24", which holds the weights "29" is driven from the end of the turbine rotor shaft by the bevel gears "6" and "8". The weights "29" are fulcrumed on the ball bearings "21" and pins "22". Their movement is transmitted to the relay by the lower spring seat "26" and is opposed by the spring "27". Hence, with the governor at rest, the spring "27" holds the governor weights in their innermost position and the relay "31" in its lowest position. The whole rotating element is carried in two bearings. The lower bearing "17" is carried in the pump case "13" which is bolted to and centered in the bearing bracket. The upper bearing "3" is a combined radial and thrust bearing and is centered in and bolted to the bearing bracket. The thrust bearing clearances as given on the "Rotor Clearance" drawing can be adjusted by means of the shims "19". The position of the bevel gear "6" can also be adjusted by means of the shims "19" and the bevel gear "8" by means of the shims "7".

The relay "31" operates within a ported sleeve "32" so as to control the flow of high pressure oil to and from the operating cylinder. The sleeve "32" is a sliding fit in the governor housing and is connected through the follow-up linkage and operating lever to the operating piston "35". Therefore, movement of the operating piston moves the sleeve "32" so as to return the relay to its neutral position after a change in speed.

The operation of the governor is as follows: With the turbine at rest, the governor weights are held in their innermost position by the spring "27". As soon as the throttle valve is opened, the unbalanced steam pressure opens the governing valves wide and moves the operating piston to its lowest position. When the turbine speed increases to normal the centrifugal force of the governor weights "29" will exceed the force of the governor spring "27" and the weights will begin to move outward. The unit is then under control of the governor.

Let us consider an increase in load, which will decrease the speed and cause the governor weights "29" to move inward. As the weights move inward the governor spring "27" moves the relay "31" downward. This downward movement of the relay opens the ports which connect the space below the piston to drain and admit high pressure oil above the piston. The piston will therefore move downward opening the governing valves sufficiently to maintain the required speed. As the piston moves downward, the operating lever moves the sleeve "32" downward, until it has reached its proper position with regard to the relay "31". Thus following any relay movement, the resulting movement of the operating piston moves the sleeve "32" so as to re-establish the relative position of the relay and sleeve at neutral.

If the load decreases, the reverse action is true, in that the governor weights then move outward, compress the governor spring "27" and move the relay upward. This uncovers the ports which connect the space above the operating piston to drain and admit high pressure oil below the piston thus moving it upward and closing the governing valves sufficiently to maintain the required speed. The relay sleeve is then moved by the upward movement of the operating piston until balance has again been restored.

SPEED CHANGER

The speed changer mechanism is shown in the upper part of the main section and in sections B-B and C-C. As shown, it is in its mid position with the follow-up lever "48" in a horizontal position. The principal parts of the electrically operated portion, are the motor "63", shaft "64", worm "58" and worm wheel "59". The principal parts of the hand operated portion of the speed changer are the handwheel "61", and shaft "62". Both the electrically operated and hand operated portion, act to regulate the speed through the worm "54" and worm wheel "43" which is threaded on the support stud "41". The position of the relay bushing "32" regulates the point at which the relay ports are opened or closed to control the speed. This bushing is attached to the lever "48" which is fulcrumed on the yoke "44". Thus it can be seen that movement of the fulcrum point will also move the bushing a proportional amount. The support stud "41" carries the worm wheel "43" in which it is threaded and the yoke "44". The motor moves the yoke "44" through the worms "58", and "54" the worm wheels "59" and "43", the shaft "64" and the friction spring "56" to screw the worm wheel "43" upward or downward on the stud "41". The handwheel performs the same operation as the motor except that it is accomplished through the handwheel "61", shaft "62", worm "54", and worm wheel "43".

DIS-ASSEMBLY AND ADJUSTMENT

All of the fundamental adjustments on this governor were made at the factory and under normal operation, no further adjustment should be required. However, if it should become necessary to dis-assemble the governor mechanism, the following should be noted.

The governor housing "23", pump gear case "13" and bearing "3" are bolted to and centered in the bearing bracket to insure correct alignment of the rotating parts.

To dis-assemble the governor:-

1. Remove the governor linkage and follow-up linkage.
2. Remove the housing "23", lifting it straight upward until it clears the relay sleeve connecting piece "47".
3. Remove the screws in the bearing "3".
4. Since the shaft "11" is connected to the gear "15" by a spline fit the entire rotating element can now be lifted straight up and out.

NOTE: Assembly is in the reverse order as noted above but one particular point should be watched. A single tooth on one of the bevel gears and two adjacent teeth on the other bevel gear are marked. The marking of these teeth is so that the single tooth can be assembled between the two marked teeth on the other gear. It is important that they be assembled in this position as these gears were "lapped in", in the machining process.

To adjust the governor relay mechanism:-

1. Set the speed changer in mid-position, that is, with the lower edge of the worm wheel "43" approximately 3/32 above the shoulder on the support stud "41", then adjust the set screw "68" so that there is a clearance of approximately 3/32 between the top of it and the lower side of the cover plate "52".
2. Adjust the lock nuts "34" until dimension "A" between the nuts "34" and the bottom of the cylinder equals one and one quarter times the valve lift specified for the last valve to be opened (see valve diagram).
3. Secure the lock nuts in this position.
4. Set the operating lever in a horizontal position as shown.
5. Adjust the length of the link "49" so that the follow-up lever "48" is horizontal.
6. Turn the speed changer handwheel counter-clockwise to the low speed limit of its travel; that is, until the lower edge of wormwheel "43" is against the shoulder on the support stud "41".
7. Admit steam to the turbine and let it turn over at approximately 600 rpm. At this speed the operating piston should be in its lowest position.
8. Raise the sleeve "32" by loosening the relay connection nut "45" and turning the sleeve "32" in a counter-clockwise direction when looking downward, until it is assured that the piston "35" is in its lowest position.
9. Keeping the turbine speed at approximately 600 rpm, loosen the relay connection nut "45" and move the sleeve "32" downward (by screwing it in a clockwise direction when looking downward) until the piston "35" just starts to rise.
10. Secure the relay connection nut "45" in this position.

To adjust the governor, proceed as follows:

1. Set the speed changer in mid-position, that is, with the lower edge of the worm wheel "43" approximately 3/32 above the shoulder on the support stud "41", then adjust the set screw "68" so that there is a clearance of approximately 3/32 between the top of it and the lower side of the cover plate "52".
2. The governor should then maintain a speed of approximately 4% above normal at no load.
3. Bring the turbine up to speed slowly, under control of the throttle valve and note the speed maintained when under control of the governor.
4. If the speed is not correct, change the tension of the spring "27". This can be done by means of the adjusting nut "30".

NOTE: To gain access to the spring adjusting nut "30", remove the rectangular cover on the side of the governor housing.

To decrease the speed turn the nut to the right. To increase the speed turn the nut to the left. One complete turn of the nut will change the speed approximately 10%. It is not advisable to give this nut more than one complete turn at a time without first observing the results.

OIL PUMP

The oil pump shown in the main section and in section A-A is of the spur gear type and is driven from the lower end of the governor shaft "11" by the bevel gears "6" and "8". It supplies oil for lubricating purposes as well as the actuating medium for operating the governing valves. Priming

openings are provided in the pump case as shown in section A-A but priming should be necessary only when starting up for the first time or when the turbine has been out of service for a long period of time.

The following list has been compiled to facilitate ordering spare or renewal parts by name and number together with the serial number of the turbine:

Item No.	Name
1	Pump Shaft Nut and Cotter Pin
2	Pump Shaft Washer
3	Bearing (Radial and Thrust)
4	Thrust Bearing Collar
5	Thrust Bearing Collar Pin
6	Bevel Gear (Driven)
7	Bevel Gear Shims
8	Bevel Gear and Key (Driver)
9	Nut and Lockwasher
10	Oil Spray Tube (Complete)
11	Pump and Governor Shaft
12	Pump Gear Idler Pin
13	Pump Gear Case
14	Pump Idler Gear
15	Pump Driving Gear
16	Pump Gear Case Cover
17	Pump and Governor Shaft Bushing
18	Cover
19	Shims
20	Pump Shaft Key
21	Governor Weight Ball Bearing
22	Governor Weight Fulcrum Pin
23	Governor Housing
24	Governor Hub
25	Governor Relay Ball Seat
26	Governor Spring Seat (Lower)
27	Governor Spring
28	Governor Weight Case
29	Governor Weight
30	Governor Spring Adjusting Nut
31	Governor Relay
32	Governor Relay Sleeve
33	Operating Piston Rod
34	Operating Piston Rod Stop Nuts
35	Operating Piston
36	Operating Piston Ring
37	Operating Piston Rod Bushing
38	Operating Piston Rod Bushing Retainer
39	Gasket
40	Operating Piston Rod Bushing Retainer Dowel Pin
41	Lever Yoke Support Stud
42	Speed Changer & Follow-Up Linkage Housing
43	Speed Changer Handwheel Shaft Worm Wheel
44	Lever Yoke
45	Relay Connection Nut
46	Pin (Center)
47	Relay Bushing Connection
48	Follow-Up Lever
49	Follow-Up Rod (Complete)
50	Follow-Up Rod Guard Plate
51	Follow-Up Lever Pin (End)
52	Speed Changer Housing Cover
53	Speed Changer Handwheel Shaft Bushing (Outer)

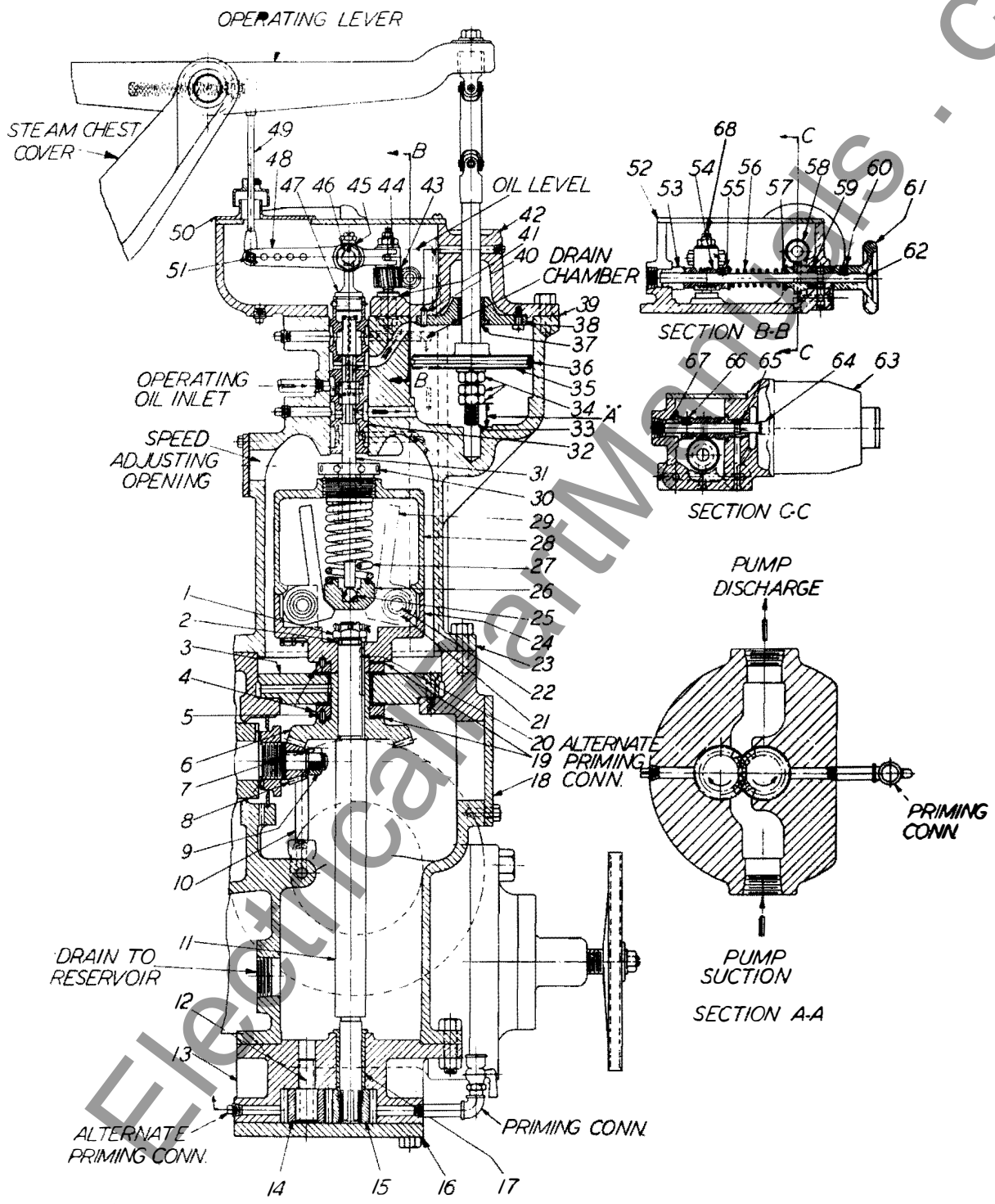

Fig. 1 - Oil Pump, Governor and Speed Changer

Item No.	Name
54	Speed Changer Handwheel Shaft Worm
55	Speed Changer Handwheel Shaft Worm Retainer and Spring Seat
56	Speed Changer Handwheel Shaft Worm Spring
57	Speed Changer Handwheel Shaft Worm Spring Washer
58	Speed Changer Motor Worm
59	Speed Changer Motor Worm Wheel
60	Speed Changer Handwheel Set Screw
61	Speed Changer Handwheel
62	Speed Changer Handwheel Shaft
63	Speed Changer Motor
64	Speed Changer Motor Shaft
65	Speed Changer Motor Shaft Worm Bushing (Inner)
66	Speed Changer Motor Shaft Worm Set Screw
67	Speed Changer Motor Shaft Bushing (Outer)
68	Speed Changer Stop Set Screw

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